oat-cell tumours separately from other undifferentiated types. Barnard (1943) believed that all these lung carcinomata probably arose from a common parent cell, and the Council for the International Organizations of Medical Sciences (1953) recommended that large, small, and oat-cell tumours should be put together in an anaplastic group. McDonald *et al.* (1951), on the other hand, when re-examining the sections of all the lung cancers seen at the Mayo Clinic between 1906 and 1948, concluded that what they call the bronchogenic small-cell carcinoma was a definite entity pathologically and clinically and should not be included in the general group of undifferentiated cancers. Foot (1952) also separates these small oat-cell tumours from the pleomorphic type. Björk (1947) regarded them as undifferentiated adenocarcinomata but classified them separately, and they made up 24% of his series from the Brompton Hospital. The evidence, therefore, for the oat-cell carcinoma being a distinct variant is conflicting, but we feel that there is enough to justify analysing them separately, particularly as in our series they were nearly all reported on by one pathologist. Graham (1954), although he would not agree with the details of our classification, thinks that some varieties of lung cancer differ from others so much that they should be regarded as distinct diseases with different aetiological factors. Both he and Doll (personal communication) think that squamous carcinomata are most closely related to cigarette smoking, and it may be that the oat-cell tumour has different causes, possibly with an inherited factor associated with the A blood group.

It would appear from the results of this investigation that rhesus-negative people are slightly less likely to develop lung cancer than those who are rhesus-positive. Aird *et al.* (1954), on the other hand, found 16.2% of rhesus-negative cases among 635 lung-cancer patients, a figure which is within normal limits for the general population of England. We therefore feel that no definite conclusion can be drawn from our figures, but it would be worth while seeing how far a significance could be maintained in a larger series taken over a longer period from the same source.

Summary and Conclusion

The blood groups of 777 histologically proved cases of carcinoma of lung in one hospital are compared with those of 1,000 blood donors in the same area. No significant or near-significant difference is found in the ABO distribution of the two series.

On breakdown into histological subdivisions an excess of group A at the expense of group O is found in the oat-cell tumours but not in the other types which have a normal ABO distribution. The significance of this is discussed.

In 555 cases tested with anti-D serum, 12.43% were rhesus negative; when compared with the control figure of 18.4% rhesus-negative this is statistically significant. The deficiency of rhesus-negatives applied particularly to the 251 squamous-cell carcinomata (8.76%). This finding is discussed.

We wish to thank the consultant surgeons and pathologists of the Liverpool Thoracic Surgical Unit for access to their case records and reports. We are grateful to Dr. P. M. Sheppard and Dr. R. Winston Evans for much help and advice in the preparation of this paper, and to Dr. D. Lehane, Medical Director, Liverpool Regional Blood Transfusion Service, for the control figures.

ADDENDUM.—Since this paper was prepared an additional series of 1,030 donors has been received from the Liverpool Regional Blood Transfusion Service. The percentage of Rh-negatives in the controls is now 17.93% of 2,030. Although this is slightly lower than the figure used in the analyses, it makes no material difference to the significance of the results. The ABO distribution of the control series has not been affected by the addition of these new donors.

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KINKING, ROTATION, AND TWISTING OF THE STOMACH

WITH SPECIAL REFERENCE TO CASCADE STOMACH AND CHRONIC GASTRIC VOLVULUS

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In routine *x*-ray work the stomach is sometimes seen to be kinked upon itself (as in the "cascade" form), or rotated in its entirety (the more obvious variety of volvulus), or twisted like a cloth being wrung dry (torsion of the stomach). It is convenient to consider these conditions together, because they are often seen with one another in the same patient and sometimes cause similar symptoms. Epigastric distension may lead to diagnostic difficulty, and pain may mimic that of cardiac ischaemia. This paper is an attempt to introduce some unity of concept into the study of these deformities and the clinical pictures which may go with them.

Anatomical Features

Kinking

This term may be used when there is angulation of the gastric wall at any other situation than that of the natural incisura angularis.

Cascade Stomach ("*Cup-and-spill*" *Stomach*).—In this condition the gas-filled fundus falls backwards, when the subject is erect, out of the main gastric axis, forming a separate pocket (Fig. 1). The gullet usually enters the medial aspect of this pocket, and swallowed fluid pools in it until the level rises high enough for a "cascade" to take place into the body of the stomach; *x*-ray illustrations are shown in Figs. 8 and 9. Since Rieder first described the condition in 1910 very many cascade stomachs must have come to operation, when they had usually already been aspirated, or to necropsy, when they were flaccid: no exact description is available of their anatomical features. Barclay (1933) was inclined, quoting Forsell, to attach some importance to the sling of oblique fibres which encircles the greater curvature; other

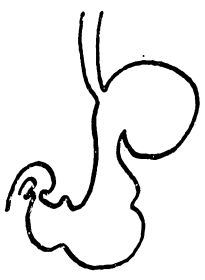

FIG. 1

theories of causation are discussed by Roussel (1952). Regelsberger, quoted by Myles (1937), estimated the frequency of cascade stomach at 3%. In our own last 200 opaque meal examinations, in which we have been looking for it specially, it has been encountered 7 times.

Jack-knife Stomach ("*Hinge Volvulus*").—Sometimes a cascade stomach is acutely kinked on itself, the angle pointing upwards and usually forwards. A selected view, typically the right anterior oblique, then shows (Figs. 2 and 10) what has been well described as a "jack-knife stomach" (Cardon *et al.*, 1947).

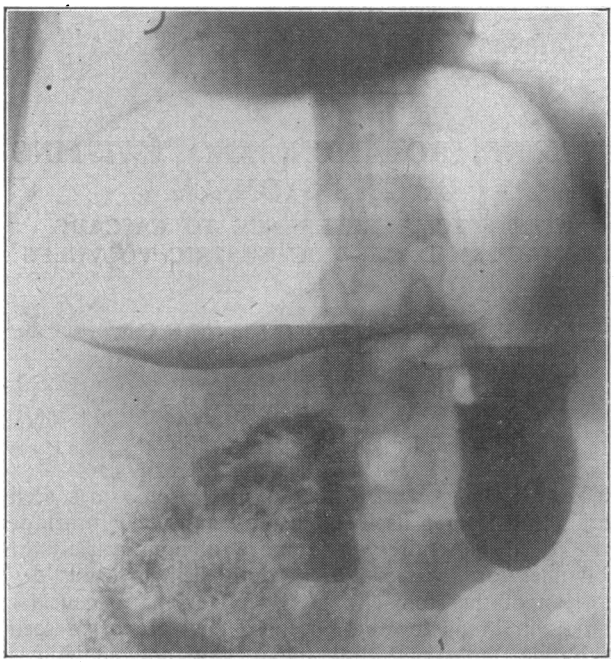

FIG. 8.—Case 1: cascade or cup-and-spill stomach.

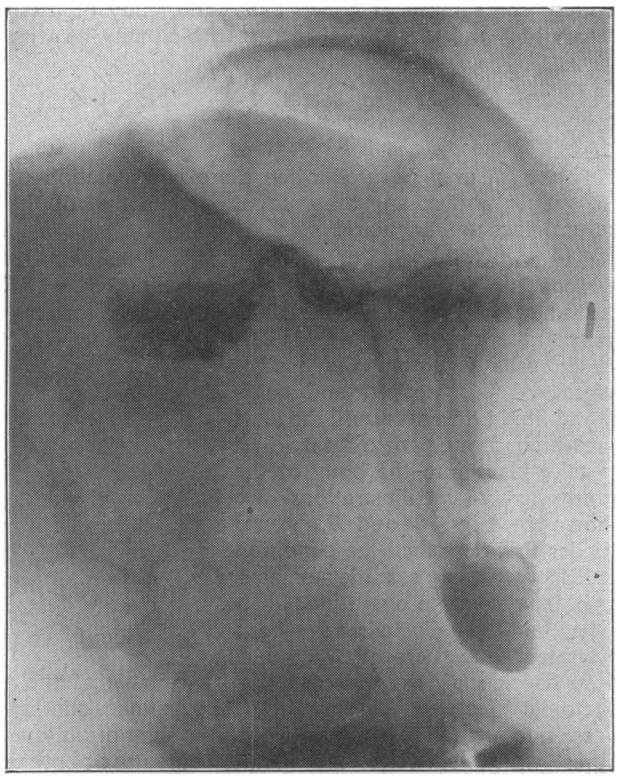

FIG. 9.—Case 2: cascade stomach, right lateral view.

Rotation

The natural stomach is fixed, or almost so, at the cardia and the pylorus. In ordinary circumstances the ligaments and vessels allow rotation through some 90 degrees round its long axis, but abnormal mobility may be permitted by slackness or rupture of these structures. Dr. Henry T. Howat and Professor Robert Platt have shown one of us films of an interesting case in which rotation occurred after splenectomy; presumably it was a consequence of operative interference with the gastro-splenic omentum and the vasa brevia. Published reports suggest that a large diaphragmatic hernia (Weeder, 1935), "eventration of the diaphragm" (Deloyers and van der Stricht, 1949), hour-glass stomach (Deaver and Ashhurst, 1921), or carcinoma of the stomach (v. Haberer, 1912) may predispose to abnormal gastric rotation. The possible influence of a distended colon is discussed later.

FIG. 2

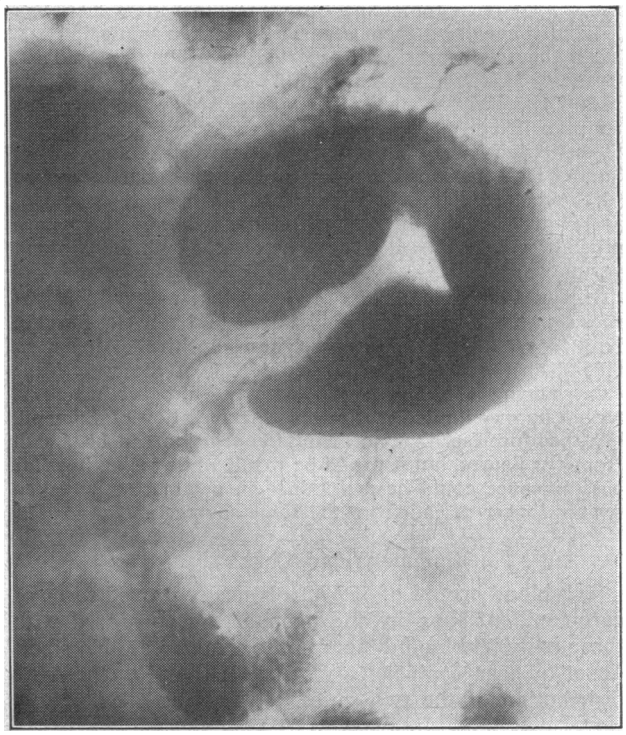

FIG. 10.—Case 3: jack-knife stomach, right lateral view with patient erect.

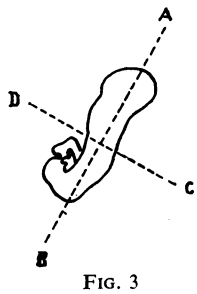

FIG. 3

It is possible for a body free in space to rotate round three different axes and combinations of these. The two main axes in the case of the stomach are shown in Fig. 3: one the long axis of the organ (AB), the other at right angles to it, but also approximately in the coronal plane (CD). The third axis, perpendicular to the page, is not shown. The two pure forms of complete gastric rotation are the longitudinal and the transverse.

Longitudinal.—In this form, called by Kocher in 1914 "*organo-axial volvulus,*" the whole stomach rotates round the axis AB. Commonly, the greater curvature moves forwards, then upwards and to the right, then backwards. Rarely (Neumann, 1906; Gharpure, 1939; Whitwell, 1952), it may be displaced first backwards, then upwards and to the right, then forwards. In either case, if the rotation stops at 180 degrees the greater curvature forms the upper border of the stomach. It is a useful distinction from extreme cascade stomach without rotation that in longitudinal rotation through 180 degrees the pyloric antrum must point downwards (Figs. 4 and 11). Films may show spiral twisting of rugal folds at cardia or pylorus. And the transverse colon may be carried upwards with the greater curvature to a position above the stomach.

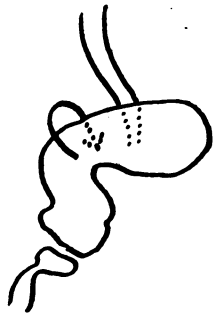

FIG. 4

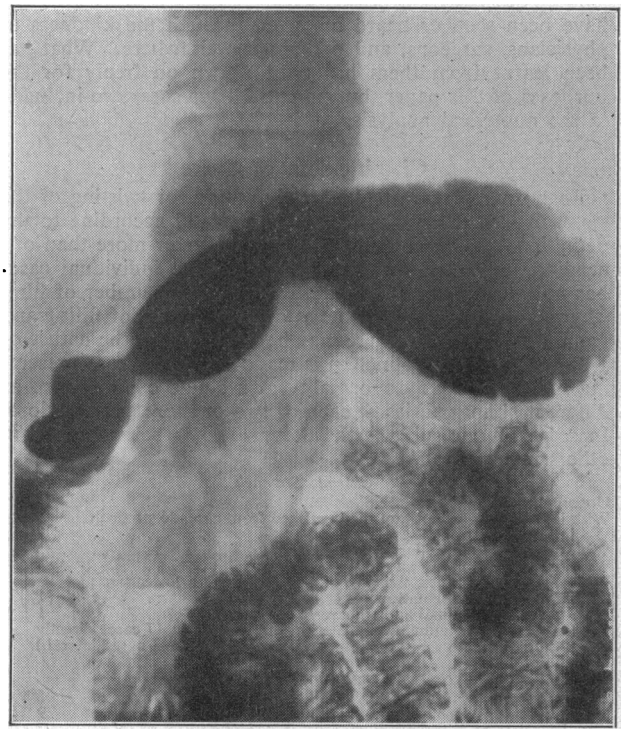

FIG. 11.—Case 4: longitudinal rotation through 180 degrees with patient erect.

Transverse ("*Mesentero-axial Volvulus*").—Here the stomach rotates round the axis CD. So far as is known, this occurs in one direction only—clockwise when one looks from the stomach towards the liver. The pyloric antrum becomes stretched and elongated, so that it ends up crossing the front of the gullet (Figs. 5 and 12).

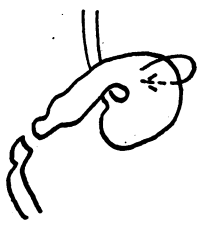

FIG. 5

Commoner than either of the pure forms of total gastric rotation is a mixed type, which may be regarded as rotation round axes AB and CD simultaneously, or round an axis intermediate between the two, and although pure rotation round the third (antero-posterior) gastric axis is unknown—it would mean, if it were through 180 degrees, ex-

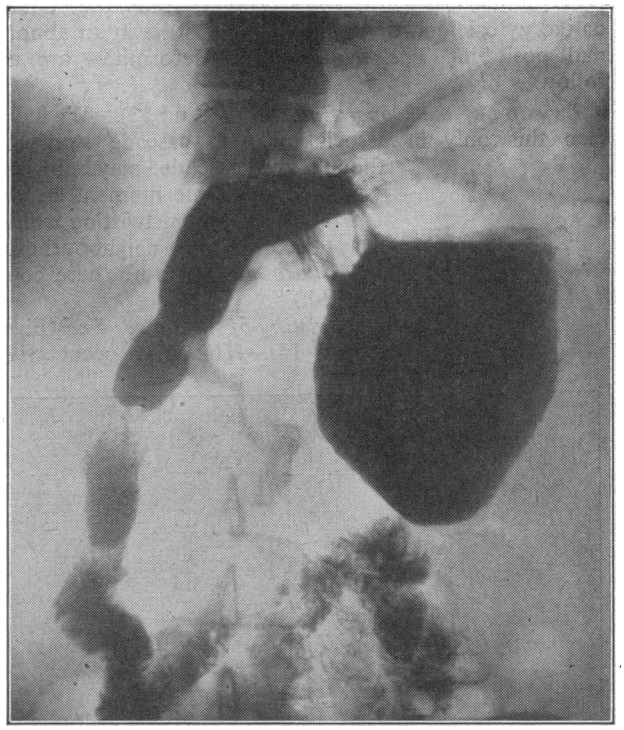

FIG. 12.—Case 5: transverse rotation through 180 degrees.

change of positions between cardia and pylorus—in occasional cases there is an element of rotation also round this axis, as those of Weiss (1923) and Meisels (1925), in which the pylorus was displaced well to the left of the midline.

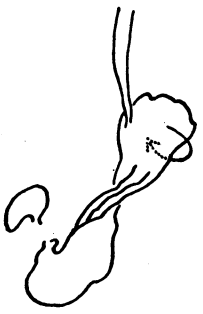

FIG. 6

Twisting

Twisting is best demonstrated in mucosal films, when the spiral arrangement of the rugae is seen. If the folds on the front and back

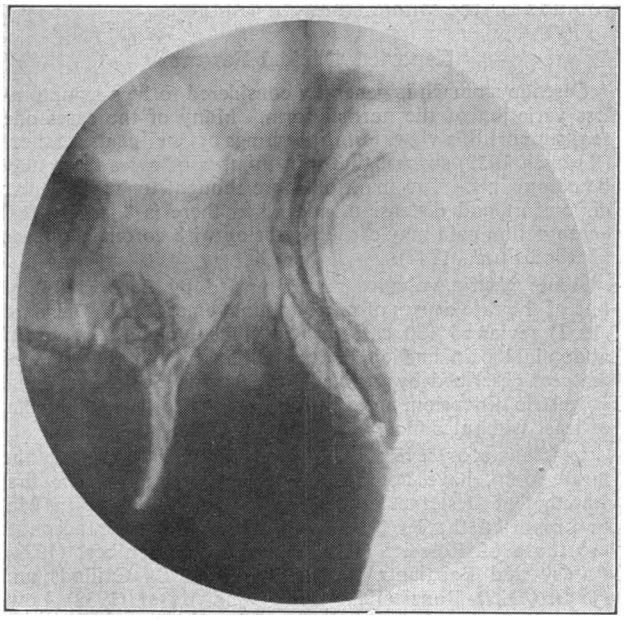

FIG. 13.—Case 6: twisting of upper part of stomach.

walls of the body cross one another, either the fundal or the pyloric end of the stomach must lie in an abnormal position. The two resulting deformities are as follows :

Twisting of the Upper End (Figs. 6 and 13).—We have seen this only in association with cascade stomach, though the cascade may not be visible at the same moment as the twist. (A very local twisting which may occur in the neighbourhood of a hiatus hernia is not here considered.)

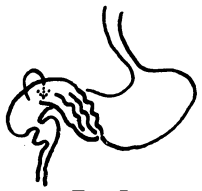

FIG. 7

Twisting of the Lower End (Figs. 7 and 14).—This may occur with cascade stomach or independently. The pyloric antrum points downwards, just as when there is longitudinal rotation of the whole stomach.

FIG. 14.—Case 7: twisting of lower part of stomach.

Reported Clinical Features

Cascade stomach is generally considered to be a symptomless variation of the normal form. Many of the cases one sees support this view, but the writings of Continental authors (Roussel, 1952) suggest that in a number of cases there may be complaints. The main ones are thought to be epigastric discomfort and distension, and when there is "jack-knife" accentuation pain may cause confusion with coronary disease (Cardon *et al.*, 1947).

Acute gastric volvulus, first reported by Berti (1866), is one of the rare causes of an abdominal emergency. Dalgaard (1952) reviewed 150 cases. The clinical picture is one of abdominal pain and circulatory collapse, with the triad of features described by Borchardt (1904)—ineffective retching, epigastric distension, and failure of a tube to pass the cardia, at least without difficulty.

Less acute or severe cases of volvulus, diagnosed in the *x*-ray room, have not attracted such attention. The first was that of Desternes and Baudon (1912). Hamilton (1945) has reported the largest series—11 cases. Other accounts are those of Rosselet (1920), Rosselet and Gilbert (1922), Choisy and Babaiantz (1927), Sutter (1928), Caillods and Cottet (1929), Ranzi (1930), Azmy and Marey (1932), Löw-Beer (1932), Myles (1937), Singleton (1940)—with a helpful review—Silverstein (1947), Cardon *et al.* (1947), and Brohée *et al.* (1949). Some of the patients had attacks of epigastric distension, discomfort, or pain, and the site and radiation of the pain have caused confusion with cardiac ischaemia.

Method of Inquiry

We have selected cases with grossly kinked, rotated, or twisted stomachs from the written records of 8,000 opaque meal examinations between 1924 and 1952, and investigated their features from the films of the stomach and colon (follow-through was usual) and from the clinical records.

It was desired to review for comparison a control series of patients without kinking, rotation, or twisting of the stomach. As most of the patients at this hospital have opaque meal examinations, and only a small proportion have gastric disease, it has been thought reasonable to consider as the control for each patient with an abnormal stomach form the next patient to have an opaque meal. One of us looked out the cases, and the other made the analysis of clinical features from the mixed records.

A number of other patients with abnormal stomach forms have been seen or heard of, often through the kindness of physicians, surgeons, and pathologists elsewhere. What has been learnt from them has been drawn on freely for the purposes of this paper, but no extraneous cases are included in the numerical analysis.

Classification of Cases

Forty-four cases with kinking, rotation, or twisting of the stomach have been classified radiologically according to the definitions given above. Many appear under more than one heading, as shown below. Decision about individual cases has not always been easy, and even when a number of films of good quality are available at different stages of filling and from different angles there may be doubt about the nature of a deformity. No distinction is made between a case presenting more than one abnormality at a single examination, or different abnormalities at each of two or more examinations. In some of our subjects the deformity has been chronic, in others intermittent.

Cascade Stomach

Uncomplicated	12	
With jack-knife stomach (not distinguished from cascade stomach in lower parts of the table)	7	
With twisting of upper part only	5	30
With twisting of lower part only	4	
With, at different times, twisting of both upper and lower parts and longitudinal rotation	1	
With mixed longitudinal and transverse rotation	1	

(In 1 case the fundus was posterior and medial, in 17 cases directly posterior, in 9 cases posterior and lateral, and in 3 cases lateral.)

Longitudinal Rotation

Uncomplicated	3	
Mixed with transverse rotation (1 with cascade stomach)	9	13
With at different times cascade stomach and twisting of both upper and lower parts	1	

Transverse Rotation

Uncomplicated	1	10
Mixed with longitudinal rotation (1 with cascade stomach)	9	

Twisting of Upper Part

Uncomplicated	0	6
With cascade stomach (1 with, on different occasions, longitudinal rotation and twisting of lower part)	6	

Twisting of Lower Part

Uncomplicated	2	7
With cascade stomach (1 with, on different occasions, longitudinal rotation and twisting of upper part)	5	

Illustrative Cases

Case 1 (*Fig. 8*).—Cascade or cup-and-spill stomach, with abnormally large air-bubble. A diabetic man of 46, who passed an excessive amount of flatus, but otherwise had no relevant symptoms.

Case 2 (*Fig. 9*).—Cascade stomach, right lateral view. The form of this stomach was substantially unchanged by air inflation of the colon, and by subsequent passage of intestinal contents following subcutaneous injection of vasopressin ; this film was taken shortly after complete evacuation of the colon. The patient was a woman of 50 with idiopathic steatorrhoea. She had attacks of irritability and

abdominal discomfort, when she was observed to swallow air copiously, to belch it a little, and to develop swelling and superresonance in the left upper quadrant of the abdomen. Colonic air inflation gave rise to the same symptoms and signs.

Case 3 (*Fig. 10*).—Jack-knife stomach, right lateral view with patient erect. A man of 51, with an irritable colon. He was many times observed in attacks of abdominal distension, and gave an account of having burst a wound after appendicectomy.

Case 4 (*Fig. 11*).—Longitudinal rotation through 180 degrees. Patient erect, as may be seen from the small air-bubble in the middle of the stomach. The pylorus points downwards. The transverse colon was above the stomach, at the level of the twelfth thoracic vertebra. The patient was a man of 50 who had some abdominal complaints and mentioned distension; the psychoneurotic nature of his illness made these symptoms difficult to evaluate.

Case 5 (*Fig. 12*).—A housewife of 48 was playing bridge when she was seized with a sudden pain across the front of the chest, with radiation to the neck, both jaws, and the fingers of both hands. It went away while she continued the game, but two days later she had a similar attack and was admitted to hospital. On this and later occasions electrocardiograms taken between attacks showed no abnormality. Other attacks, often with abdominal distension and palpitation, were thought to be relieved by glyceryl trinitrate, but as no attack was ever prolonged this effect could not be established. Two years after the first attack a laparotomy was made and the stomach was found in an abnormal position. It was anchored by stitches, as it was thought, where it should have been, but *x*-ray films taken when she came to this hospital five years later showed transverse rotation through 180 degrees. Note the drawn-out and downward-pointing pyloric antrum.

Case 6 (*Fig. 13*).—Twisting of mucosal folds in the body of the stomach. The pyloric end of the stomach is in normal position. The direction of the twist is shown in other films by the demonstration that the oesophagus crosses the front of the fundus to reach the cardia. Other examinations from 1926 to 1952 showed sometimes a cascade form, sometimes jack-knife kinking, sometimes twisting of the pyloric end, and once probably longitudinal rotation; the air-bubble was sometimes very large. The patient, a man of 52, had at one time an ulcer high on the lesser curvature; he mentioned abdominal distension and discomfort in the right side of the abdomen.

Case 7 (*Fig. 14*).—Twisting of the pyloric end of the stomach. Note crossing mucosal folds in the body of the stomach, and downward-pointing pyloric antrum. The transverse colon was just above the pyloric end of the stomach, at the level of the first lumbar vertebra. The patient was a woman of 55 who had had a cholecystectomy five years before and then two operations for adhesions. Her symptoms were probably not relevant to the gastric deformity.

Analysis, with Comments

The following significant differences were found between patients with these abnormal forms of stomach and the controls:

Sex Distribution.—The patients with abnormal stomach forms were 32 men and 12 women; the controls were 26 men and 18 women. The higher proportion of men in the first group derives from the uniform male sex of the 13 patients with longitudinal rotation (including the 10 patients with other abnormality of form in addition). The odds against this uniformity of sex happening by chance are more than 50 to 1 ($P<0.02$).

Adhesions.—Operative or *x*-ray evidence of adhesions was recorded in seven of the patients with abnormal stomach forms and in two of the controls; this difference is not statistically significant, but of seven patients with jack-knife stomach three gave evidence of adhesions ($P<0.02$).

Really Severe Distension.—Eight of the 44 patients with abnormal stomach forms had either been observed in really severe attacks of abdominal distension or gave stories of them, compared with only 1 of the 44 controls, a man with gall-stones ($P<0.05$). These eight cases were distributed between all the main groups in our classification. Two patients with jack-knife stomach gave a history of abdominal wounds having burst after operations, and a patient with longitudinal rotation has since had the same surgical accident. In another patient with twisting of the lower stomach the girth of the abdomen increased 5 in. (12.5 cm.) during an attack. There was repeated mention of tympanites and splashing in the records.

Gastric Air-bubble.—An abnormally large air-bubble was present in 19 of the patients with abnormal stomach forms and in two of the controls ($P<0.01$).

Left Dome of the Diaphragm Higher than Right.—This was observed in nine of the patients with abnormal stomach forms, and in one of the controls ($P<0.02$).

High Left Colic Flexure.—Present in 26 of the patients with abnormal stomach forms and in 10 of the controls ($P<0.01$).

Distended Left Colic Flexure.—Present in 10 of the patients with abnormal stomach forms and in two of the controls ($P<0.05$).

Abnormally High Transverse Colon.—The mid-transverse colon was at the level of the eleventh and twelfth thoracic vertebrae in the two cases of pure longitudinal rotation in which the stomach was in the abdomen. In none of 36 controls in which the level could accurately be determined did it rise so high ($P<0.01$).

Certain further features were noted in the cases with abnormal stomach forms, though a statistical correlation was not established:

In two patients *past surgery* seemed to have been responsible for the gastric deformity.

In one patient *gastric carcinoma* was perhaps responsible for the deformity.

Massive diaphragmatic hernia was a feature in two of the abnormal cases.

In two patients, one with a jack-knife stomach and one with transverse rotation, there was *retrosternal pain radiating down the arms* with no relation to exertion; electrocardiograms were normal between attacks. This occurred in three other cases of gastric rotation which are not in the present series.

Regurgitation, vomiting, and belching were all rather more frequent in the abnormal group than among the controls.

A number of other possible associations investigated were not found to differ in the two groups: mean age and weight (allowing for sex) were similar, and various categories of abdominal disorder occurred with comparable frequency.

In 9 of the 44 patients with cascade stomach or volvulus the main symptoms for which they sought relief appear to us to have been associated with the gastric deformity. In only one case did the deformity influence a decision about treatment in favour of gastric surgery.

Discussion

Evidence has been produced that there is an association between certain abnormal stomach forms and both gastric pneumatosis and a high distended left colic flexure. Gas in the stomach and in the intestine is largely ingested air (Maddock *et al.*, 1949); but the available facts do not settle whether in our cases air-swallowing or gastric deformity or an abnormal colon was the primary factor. We have seen cases in which psychoneurotic air-swallowing seemed to be the main feature, and the shape and position of the stomach might well be altered by such a habit; on the other hand, the discomfort associated with an abnormal stomach may aggravate the tendency to swallow air. It is recognized that the left half of the transverse colon can produce a filling defect in the greater curvature or even a "bilocular stomach," but the deformities considered in this paper are rather different. In two recent patients, one with cascade stomach and the other with a mixed type of rotation, films of the stomach were taken after colonic air inflation, and again when the colon had been emptied after subcutaneous injection of vasopressin ("pitressin"); in neither case was deformity much affected.

The most common clinical feature in our cases has been epigastric distension due to gastric and colonic pneumatosis. Ramond (1927) did not write specially about abnormal gastric forms, and indeed he believed that the cascade appearance was secondary to distension, but he emphasized

that patients might be distressed by a large gastric air-bubble. He thought an aggravating feature might be failure of the cardia to relax and allow belching, an *aérophagie bloquée* being more troublesome than an *aérophagie libre*. The condition he described as *aérophagie* included *aérogastrie* and *aérocolie*, for he pointed out that most swallowed air which is not belched back must pass on into the lower bowel. His attractive and logical writings used to be quoted by Hurst, who described imprisonment of the gastric air-bubble in oesophageal ulcer (Hurst, 1934) (incidentally, the published films of his main case show a cascade stomach), and believed that "wind round the heart" also occurred (Hurst, 1938, 1942) if the gastric cardia was dislocated by an excess of gas in the left colic flexure; then the vicious circle might be broken by an injection of vasopressin.

Sometimes, both in cases in the literature and in others we have come across ourselves, epigastric or low chest pain has radiated to the neck, jaws, arms, and hands. The mimicry of ischaemic heart pain is striking and misleading, though a recurrent tendency may exclude coronary occlusion, while there is not the constant relation to exertion which one expects in angina of effort. Similar radiation of pain is sometimes seen in hiatus hernia and high lesser-curve gastric ulcer. It is hardly surprising, for there are communications between the sympathetic nerve supplies to heart and gullet (Kuntz, 1946). It is also possible, as Roemheld (1931) suggested might happen in his "gastro-cardiac syndrome," that the heart is embarrassed by upper abdominal distension. It is interesting that Dworken *et al.* (1952) should describe pain like that of cardiac ischaemia in their "splenic flexure syndrome."

It is usually unnecessary to mention the abnormal form of stomach to these patients, and most of them require no treatment. If abdominal distension is troublesome they should be advised against gulping food or drink, and it should be explained that unconscious air-swallowing often accompanies attempts to belch. It may be helpful for them to avoid greens, and to take a level teaspoonful of charcoal three times daily after food. We have not yet used vasopressin regularly in any case. We have instructed one patient (not in this series) in the use of a fine stomach-tube, after showing him the relief it could give, but he did not carry on with it: it is stated that in some cases with severe rotation a fine stomach-tube, or even a large one, cannot be passed. More troublesome recurrent attacks may rarely justify surgery, such as partial gastrectomy or gastropexy (either simple or by means of gastrostomy with later closure); Anagnostidis (1935) has reviewed the operations for gastric volvulus done up to the time of his report. The treatment of acute gastric volvulus is usually surgical, with parenteral replacement of fluid and electrolytes. But cascade stomach and gastric rotation and twisting are usually unimportant incidental findings, and the greatest harm they are in most cases likely to do is to interest a physician or surgeon who does not recognize this fact.

When laparotomy is considered for any reason in a patient with one of these deformities the risk of severe post-operative distension should be borne in mind: 3 out of 44 patients in this series had burst abdomens before or after they were here.

Summary and Conclusions

Kinking, rotation, and twisting of the stomach are usually incidental *x*-ray findings. There is, however, an association with pneumatosis of the stomach and of the left colic flexure. Patients may complain of discomfort and distension in the upper abdomen, and there is a risk of burst abdomen after laparotomy. Pain may occur with similar radiation to that seen in cardiac ischaemia.

We are indebted to Dr. F. Avery Jones, who stimulated this study and helped with its presentation; and to past and present physicians at Ruthin Castle, whose records form the basis of the work.

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DIAGNOSIS AND RESULTS OF TREATMENT OF CANCER OF THE PANCREAS AND AMPULLA OF VATER

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In spite of many statements to the contrary (Robson and Moynihan, 1902), there is a widespread impression that carcinoma of the pancreas produces painless progressive jaundice. The case histories of 190 patients have been studied, the majority of whom have been under the care of one or other of us, the remainder being under the care of colleagues at St. George's or St. Mary's Hospitals. As a result of this study we have come to the conclusion that most of the standard textbook descriptions of this disease are incorrect. In this paper we discuss the symptoms and signs of carcinoma of the pancreas in an effort to make the diagnosis easier, and we present the results of treatment, which show that diagnosis at an operable stage has been of value.

Diagnosis

Carcinoma of the pancreas is a disease of middle and later life; in our series the youngest patient was aged 43 and the oldest 89. The majority of cases occurred in patients between 50 and 70 years of age. Table I gives the anatomical situation of the primary tumour within the pancreas. It will be seen that in 128 patients (67.3%) the carcinoma arose in the head of the pancreas or in the ampulla of Vater; in 51 patients (26.8%) it was placed in the tail and